ECOLOGY OF A SEWAGE-FED FISH POND

DISSERTATION SUBMITTED IN
PARTIAL FULFILMENT FOR THE
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IN
ZOOLOGY

BY

Mohd. Javed Kamal Shamsi

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DEPARTMENT OF ZOOLOGY

ALIGARH MUSLIM UNIVERSITY
ALIGARH, (U. P.) India

Phone : University 285
Public 5646
Res. 4805
4042

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1 ENTOMOLOGY
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5 GENETICS

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This is to certify that the dissertation entitled 'Ecology of a Sewage-fed fish pond' has been completed under my supervision by Mr. Mohd. Javed Kamal Shamsi. The work is original and has been independently pursued by the candidate.

I permit the candidate to submit the dissertation in partial fulfilment for the award of the degree of Master of Philosophy in Zoology of the Aligarh Muslim University, Aligarh.

A.K. JAFRI, M.Sc. Ph.D.
Reader

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GENERAL INTRODUCTION

Inland water resources in India are quite extensive. Efforts should be made towards their utilization for pisciculture. Scientific management of fish population requires a thorough study of the prevailing essential factors which singly or collectively influence the life of fishes. The present study was designed to provide information on some aspects of the ecology, including the physico-chemical condition of the water and production of planktons and benthos, of a sewage-fed fresh water perennial pond located in the Aligarh district (Lat. 27° 34' 30" N. Long. 38° 4' 26" E.). It is located in the University Campus, close to the residential area and covers an area of about 0.8 hectares. The maximum depth of is about 5 feet and the shore line is slopy. Water level in the pond fluctuates depending upon the amount of discharge in it. This pond is now being used for stocking major carps, namely, *Labeo rohita*, *Catla catla* and *Cirrhina mrigala*. A survey of recent literature reveals that the importance of the sewage utilization for pisciculture is being increasingly realized. Nutrients present in the sewage have been observed to increase the fertility of pond and sustain rich plankton biomass, a condition so essential for intensive cultivation of major carps.

The use of sewage effluent for raising fish production in india has been emphasized by Arceivala *et al.* (1970), Saha (1970) and Jhingran (1975). The available data reveals fish production from farms receiving treated sewage varying from 1,000 - 6,000 kg/ha/yr. In Bengal, where sewage is extensively utilized for pisciculture, the sewage-fed resources amount to about 38,000 hecteres with a fish yield 2,225 kg/ha.

PART - I

PHYSICO-CHEMICAL CONDITION AND PLANKTON

INTRODUCTION

A proper understanding of aquatic ecology requires a knowledge of the organism living in the environment as well as of the factors which directly or indirectly effect them. Planktons constitute a very important part of the fulwater ecosystem. Their basal position in the food pyramid of a pond is such that a major change in their population can potentially alter the entire biomass production. Significance of plankton in the energy flow in an aquatic system is well established. Efforts are made to enhance productivity of these plankters through environmental links which constitute the natural food of commercially important cultivable species of major carps. The theme of the present work was to undertake broad spectrum investigations of the pond ecosystem and then to identify physico-chemical factors influential on planktonic communities. A survey of literature reveals that work of this nature has been carried out w in the past on ponds and reservoirs in India (Verma, 1967, Vijayraghavan, 1967; Michael, 1969; Vasisht, 1968; Khan and Qayyum, 1970; Rao, 1971, 1972, 1975, 1977; Saha _et al_., 1971; Ghosh _et al_., 1974;

Mathew, 1975; Moore, 1980) but there seems a general paucity of information on freshwater bodies which receive a regular supply of sewage and are used for pisciculture. A perennial pond fed with sewage in which intensive carp culture is practiced was selected for the said limnological observations.

MATERIALS AND METHODS

Samples of water and plankton were collected from different sub-stations in the pond in the middle of each month from October, 1980 - March, 1981. For plankton study 100 ml of water was procured from surface and Lugol's solution added to a concentration of 1% to preserve the phytoplankton. Incubation of the sample for 24 hours at room temperature resulted in sedimentation of phytoplankton. About 90 ml of supernatant liquid was siphoned off and measured volume of the remaining 10 ml plankton concentrate were analysed under a microscope. The analysis included identification of phytoplankton upto generic level and their numerical estimation. The mean number of phytoplankton of the two stations was expressed per litre of environmental water. Zooplanktons were also collected from the two sites in the pond selected for phytoplankton. Fifty litres of water was filtered through a plankton net made up of organdi cloth. The zooplankton concentrate received formaldehyde to a concentration of 10% for preservation. Sub-samples from this preserve were then put under microscope for qualitative and quantitative analysis of zooplankton. Keys suggested by Ward & Whipple (1963) and Needham & Needham (1964) were used for identification of the phyto- and zoo-plankton.

Surface water and atmospheric temperatures were recorded by the help of centigrade thermometer. The water transparency was measured by standard secchidisc. pH of water was determined by the help of pH indicator paper.

Oxygen concentration was estimated by the standard Wrinkler's method and carbondioxide tested using phenolphthalin. Carbonate and bicarbonate were analysed by titerating 100 ml of water sample with 0.02 N - H_2SO_4, using phenolphthalin and methyl orange as indicators. These methods were adopted from Theroux <u>et al</u>. (1946). Chloride concentration was determined by titerating 50 ml of water sample with Silver nitrate solution and selecting potassium chromate as an indicator (Barnes, 1959).

RESULTS AND DISCUSSION

Results of the monthly variation in physico-chemical properties of water as well as qualitative and quantitative composition of phytoplankton and zooplankton have been summarised in Tables I, II, III Fig. I, II, III.

The variations in physical properties of water which influenced the plankt-onic life were brought about by atmospheric conditions. Some important factors being air temperature, wind velocity, development of clouds and intensity of solar radiations. Meteorological effects on the hydrobiological characteristics are well documented (Ruttner, 1953; Hutchinson, 1957; Nasar et al. , 1974). The present observations reveal that increased penetration of light in water of relatively high transparency and turnover of nutrients favour the growth of plankton to a certain level, after which these organisms lower the nutrient level by substantial uptake, reduce the water transparency which ultimately manifest in curtailment of their own population. However, death and decomposition of plankton and nutrient regeneration tends to arrest and reverse this process.

Analysis of the fluctuation in chemical conditions of water including the pH, dissolved oxygen, chloride, carbonate and bicarbonate also reveal interesting patterns of inter relations. The pH value varied between 7.9 and 8.5, which as documented by Hora & Pillay (1962) is conducive to the growth of plankton and favourable for pisciculture. According to Lauff (1953), George (1966) and Jana & Sarkar (1971) the said pH range effects the aquatic life through changes the total alkalinity. No factor can be singly pin-pointed to explain its contribution to the variation in the dissolved oxygen content, since several parameters such as temperature , partial pressure of the gas in water and rate of photosynthesis work simultaneously. Dissolved oxygen was low during morning hours and high during the afternoon. The pattern was so consistent that it leads to believe that the magnitude of the influence of photosynthesis exceeded the role of other factors which could require a greater range of variations than the one encountered during the course of this study, to be distinctly influential.

Monthly fluctuations in chloride could be caused by water level and sewage effluents. Discharge of the water dilutes the medium and lowers the chloride whereas the amount of fluctuations caused by the sewage depends upon the strength of chloride present therein. The findings of Rao & Govind (1964) and Saha et.al. (1971) vis-a-vis difference in chloride related to depth of the water body could not be substantiated.

The absence of carbondioxide from the pond water can be attributed to its uptake and assimelation in the process of photosynthesis. Other workers (Govind, 1967; Upadhayaya, 1964 and Sreenivasan, 1972) also did not report free carbondioxide in the lacustrine environments selected for the study. Patterns of carbonate and bicarbonate variation was rather interesting to note. Bicarbonate was maximum in

February when photosynthetic rate was high. The carbonate contents remaining in the water was, therefore, bound to change proportionately and maintain a relation with the bicarbonate. In the study reported here, the said relation was none too strong perhaps because of other factors operating in the ecosystem.

The physical and chemical factors outlined above appeared to influence the phyto - and zooplankton communities. Their proportion dwindled with low temperature, poor radiations and high turbidity caused chiefly by suspended matter. Chandler & Weeks (1954), Sreenivasan (1964a) and Kannan & Job (1980a) observed remarkable changes in physico-chemical properties of water and plankton by climatological conditions leading to rainfall.

SUMMARY

Variations in some hydrobiological conditions of the pond were studied from October, 1980 - March, 1981. The factors observed include temperature, transparency, pH, dissolved oxygen, chloride , carbonate and bicarbonate. The biological aspect considered comprised of the planktonic communities. Various environmental and biological correlates were identified and discussed.

TABLE - I

AIR TEMPERATURE AND PHYSICO-CHEMICAL CONDITIONS OF THE POND

Factors	MONTHS					
	October	November	December	January	February	March
Air temperature (^{o}C)	32.0	27.0	19.0	18.0	20.5	20.0
Water temperature (^{o}C)	28.0	18.5	15.5	16.5	19.5	18.0
Transparency (cm)	18.0	17.5	16.0	15.5	23.5	21.5
pH	7.9	7.9	8.2	8.2	8.5	8.2
Dissolved Oxygen (ppm)	6.4	4.8	5.2	4.3	2.7	2.5
Carbondioxide (ppm)	-	-	-	-	-	-
Carbonate (ppm)	6.0	8.5	7.5	8.0	9.0	9.6
Bicarbonate (ppm)	80.0	84.5	86.0	90.0	93.5	92.0
Chloride (ppm)	15.3	22.8	24.0	19.4	26.6	41.6

TABLE -II

PHYTOPLANKTON ABUNDANCE IN THE POND(NUMBER/LITRE)

October Total Number	October %	November Total Number	November %	December Total Number	December %	January Total Number	January %	February Total Number	February %	March Total Number	March %	Mean Tótal Number	Mean Percenta
175000	7.7	170000	6.8	140000	5.6	95000	3.4	70000	2.8	-	-	108333	4.383
70000	3.1	78500	3.1	52500	2.1	82000	2.9	37500	1.5	90000	4.8	68416.66	2.916
135000	5.9	80000	3.2	74000	2.9	90000	3.2	125000	5.1	-	-	84000	3.383
160000	7.0	95000	3.8	76000	3.0	85000	3.0	88.000	3.6	90000	4.8	99000	4.2
-	-	-	-	40000	1.6	45000	1.6	48000	1.9	-	-	22166.66	0.85
25000	1.1	28000	1.1.	45000	1.8	15000	0.5	22000	0.9	28500	1.5	27250	1.15
60000	2.6	75000	3.0	95000	3.8	90000	3.2	750000	3.0	50000	2.6	74166.66	3.033
110500	4.8	95000	3.8	55000	2.2	45000	1.6	22000	3.9	18000	0.9	57583.33	2.366
137500	6.0	165000	6.6	111500	4.4	95000	3.4	-	-	35000	1.9	90666.66	3.716
873000	38.2	786500	31.4	689000	27.4	642000	22.8	487500	19.7	311500	16.5	631583.3	26.0
-	-	150000	6.0	120500	4.1	112500	4.0	95000	3.8	100000	5.3	93333.33	3.866
-	-	-	-	8500	0.3	11500	0.4	15800	0.6	30500	1.6	11000.	0.483
-	-	85000	3.4	90000	3.6	95000	3.4	112500	4.6	115000	6.1	82916.66	3.516
-	-	-	-	35000	1.4	50000	1.8	65000	2.6	45000	2.4	32500	1.366
112500	4.9	160000	6.4	175000	6.9	132500	4.7	100000	4.0	110000	5.8	131666.66	5.45
-	-	60000	2.4	55000	2.2	45000	1.6	25000	1.0	18000	0.9	33833.33	1.35
40000	1.7	25000	1.0	27000	1.1	21000	0.7	30000	1.2	30000	1.6	28833.33	1.216
30000	1.3	32500	1.2	33000	1.3	28500	1.0	15500	0.6	12500	0.7	25333.33	1.033
15000	0.6	10000	0.4	90000	3.6	95000	3.4	32500	1.3	45000	2.4	47916.66	1.95
75000	3.7	110500	4.4	107500	4.3	62500	2.2	75000	3.0	32500	1.7	[illegible]	[illegible]

Coccochloris	-	-	-	-	25000	1.0	32000	1.1	32000	1.1	65000	2.6	30000	1.283
Chlorococcum-humicola	-	-	25000	1.0	32500	1.3	48000	1.7	52500	2.1	95000	5.0	42166.66	1.85
GREEN ALGAE	330000	14.3	735500	29.4	860500	34.3	834000	29.6	719000	28.8	691000	36.5	695000	28.8
Gonatozygon	40000	1.7	50000	2.0	70000	2.8	85000	3.0	87500	3.5	-	-	55416.66	2.166
Closterium	95000	4.2	112500	4.5	105000	4.2	137500	4.9	130000	5.3	165500	8.8	124250	5.316
Desmidium	27500	1.2	22500	0.9	17500	0.9	27000	1.1	32300	1.7	32000	1.7	25333.33	1.083
Cosmarium	-	-	18000	0.7	16500	0.6	22500	0.8	25000	1.0	30000	1.6	18666.66	0.783
Staurestrium	35500	1.5	-	-	32000	1.3	62500	2.2	62500	2.6	55000	2.9	41666.66	1.75
DESMIDS	198000	8.6	203000	8.1	241000	9.6	333000	11.8	334500	13.5	282500	15.0	265333.33	11
Cycletella	30500	1.3	45000	1.8	29000	1.1	48500	1.7	52500	2.1	47500	2.5	42166.66	1.75
Cocconies	95000	4.7	-	-	35000	1.4	90000	3.2	95500	3.9	65500	3.5	63500	2.783
Nitzschia	187500	8.2	165000	6.5	82500	3.3	165000	5.8	72500	2.9	45000	2.4	119583.33	4.866
Synedra	227000	9.9	260000	10.4	207500	8.2	245500	8.7	267500	10.8	210500	11.2	236333.33	9.866
Navicula	-	-	40000	1.6	32500	1.3	55000	1.9	45000	1.8	37500	2.0	35000	1.433
Tabellaria	-	-	15500	0.6	95500	3.8	112500	4.0	105500	4.3	10500	0.5	56583.33	2.2
Pleurocaster-lunaris	-	-	85500	3.4	77500	3.1	97500	3.4	95500	3.9	75000	3.6	70583.33	2.9
DIATOMS	540000	24.1	611000	24.6	559500	22.2	814000	28.7	734000	29.7	384000	25.7	623750	25.83
Volvox	55000	2.4	22500	0.9	32500	1.3	42000	1.5	45500	1.8	45000	2.4	40416.66	1.7
Chlamydomonas	155000	6.8	76000	3.0	77500	3.1	87500	3.1	80000	3.2	15000	0.8	81833.33	3.33
Euglina	60000	2.6	32500	1.3	30000	1.2	25500	0.9	18000	0.7	15500	0.8	30166.66	1.25
Trinema	40000	1.7	150000	0.6	11500	0.4	[illegible]	0.6	15500	0.6	10000	0.5	18250	0.73
Pleuretrachia	30000	1.3	17500	0.7	15000	0.6	22500	0.8	30000	1.2	26500	1.4	23583.33	1.0
PHYTOFLAGELLATES	340000	14.8	163500	6.5	166500	6.6	195000	5.9	189000	7.5	111500	5.9	194250	7.86
TOTAL PHYTOPLANKTON	2281000		2499500		2516500		2818000		2464000		1880500			

TABLE - III

ZOOPLANKTON ABUNDANCE IN THE POND (NUMBER/LITRE)

Genera	October		November		December		January		February		March		Mean Total Number	Mean Percentage
	Total Number	%	Total Number	%	Total Number	%	Total Number	%	Total Number	%	Total Number	%		
Chlamydomonas	125	3.0	150	2.7	175	2.6	200	4.2	100	1.8	-	-	125	2.38
Euglina	150	3.7	87	1.6	337	5.0	112	2.3	275	4.9	125	5.6	181	3.85
Volvox	150	3.7	87	1.6	162	2.4	50	1.0	-	-	-	-	74.83	1.45
Hartmanella	125	3.0	-	-	75	1-1	50	1.0	-	-	-	-	41.66	0.85
Astasia	15	0.4	25	0.4	40	0.6	62	1.3	-	-	-	-	23.66	0.45
PROTOZOANS	565	13.8	349	6.3	789	11.7	474	9.8	375	6.7	125	5.6	446.16	8.96
Pleurotrachia	212	5.2	100	1.8	105	1.6	112	2.3	75	1.3	-	-	100.66	2.03
Rotaria	15	0.4	75	1.4	225	3.4	100	2.1	-	-	-	-	69.16	1.21
Brachionus	500	12.2	250	4.5	812	12.1	175	3.7	-	-	-	-	289.9	5.416
Trinema	287	7.0	150	2.7	200	3.0	112	2.3	75	1.3	-	-	137.33	2.716
Pempholyxsulcata	125	3.0	121	2.2	225	3.4	250	5.3	200	3.6	-	-	153.5	2.916
Filinia	25	0.6	40	0.7	70	1.0	150	3.2	562	11.8	-	-	157.83	2.88
Keratella	525	12.8	700	12.7	275	4.1	100	2.1	675	12.0	-	-	379.166	7.283
Asplanchna	-	-	-	-	625	9.3	587	12.4	425	7.6	.	.	272.83	4.88
ROTIFERS	1689	41.2	1436	26.1	2537	37. 9	1586	33.4	2112	37.6	-	-	1560	29.3
Daphnia	-	-	375	6.8	50	0.7	100	2.1	375	6.7	400	18.1	216.66	5.73
Ceriodaphnia	-	-	75	1.4	50	0.7	37	0.8	237	4.2	200	9.0	99.83	2.66
Sida	-	-	100	1.8	.	-	50	1.0	-	-	100	4.5	41.66	1.21

Leptodora	-	-	-	-	-	-	-	-	150	2.7	50	2.3	33.33	0.83
Simocephalus	-	-	100	1.8	-	-	-	-	-	-	-	-	16.66	0.3
Diaphanosoma	-	-	-	-	-	-	-	-	200	3.6	-	-	33.33	0.6
CLADOCERONS	-	-	650	11.8	100	1.4	187	3.9	962	17.2	828	37.3	454	11.93
Diaptomus	412	10.1	450	8.2	662	9.9	850	17.9	612	10.9	462	20.9	574.16	12.98
Cyrtodepsis	212	5.2	225	4.1	475	7.1	100	2.1	50	0.9	-	-	177	3.233
Canthocamptus	300	7.3	562	10.2	550	8.2	200	4.2	-	-	-	-	268.66	4.983
Orelops	325	7.9	725	13.2	375	5.6	468	13.9	187	3.3	75	3.4	391.5	7.883
Eubranchipus	150	3.7	687	12.5	900	13.5	475	10.0	400	7.1	375	16.9	497.83	10.616
COPEPODS	1399	34.2	2649	48.2	2962	44.3	2287	48.1	1249	22.2	912	41.2	1909.66	39.7
Nauplii	275	6.7	187	3.4	200	3.0	112	2.3	425	7.6	125	5.6	220.66	4.766
Zygotes	162	3.9	225	4.1	90	1.3	100	2.1	487	8.7	225	10.2	214.83	5.05
EGGS & NAUPLII	437	10.6	412	7.5	290	4.3	212	4.4	912	16.5	350	15.8	435.5	9.81
TOTAL ZOOPLANKTON	4090		5496		6678		4746		5610		2212			

Fig. I

Monthly variations in air temperature and some physico-chemical conditions of water of the pond.

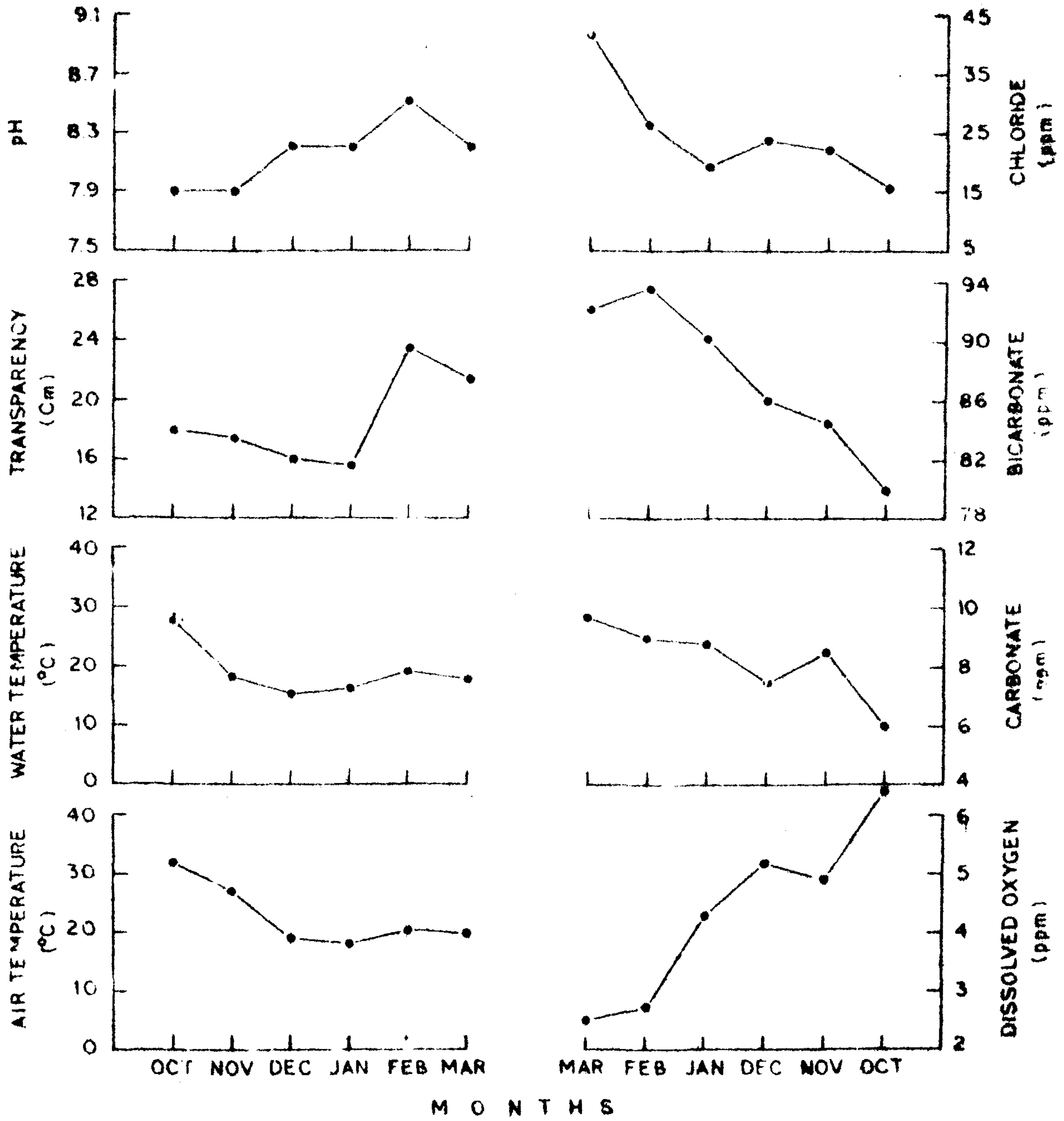

pH
TRANSPARENCY (Cm)
WATER TEMPERATURE (°C)
AIR TEMPERATURE (°C)
CHLORIDE (ppm)
BICARBONATE (ppm)
CARBONATE (ppm)
DISSOLVED OXYGEN (ppm)
OCT NOV DEC JAN FEB MAR
MAR FEB JAN DEC NOV OCT
MONTHS

Fig. II

Abundance of main groups of phytoplankton in the pond in different months (total number indicated by black bars & percentage by white bars).

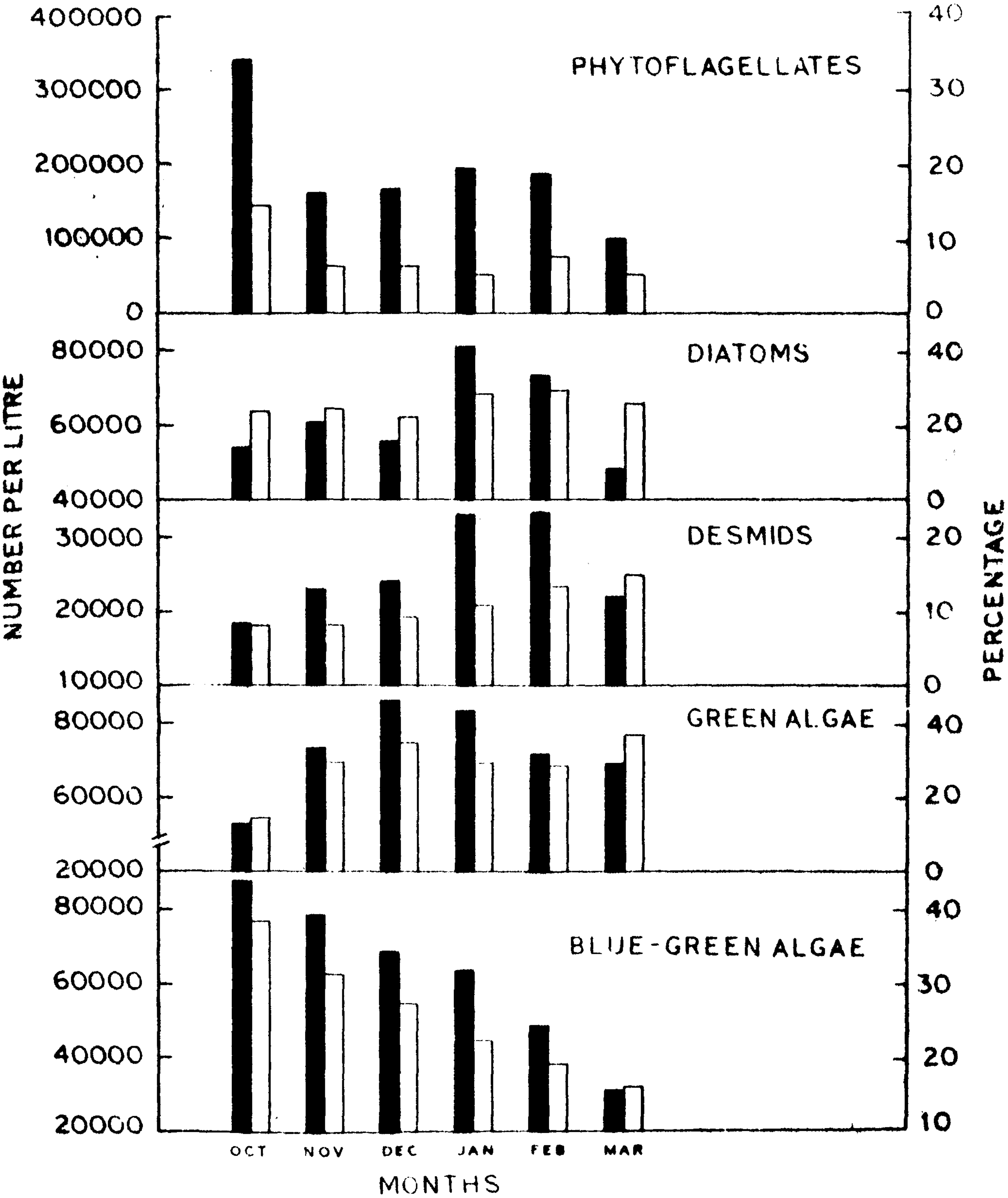
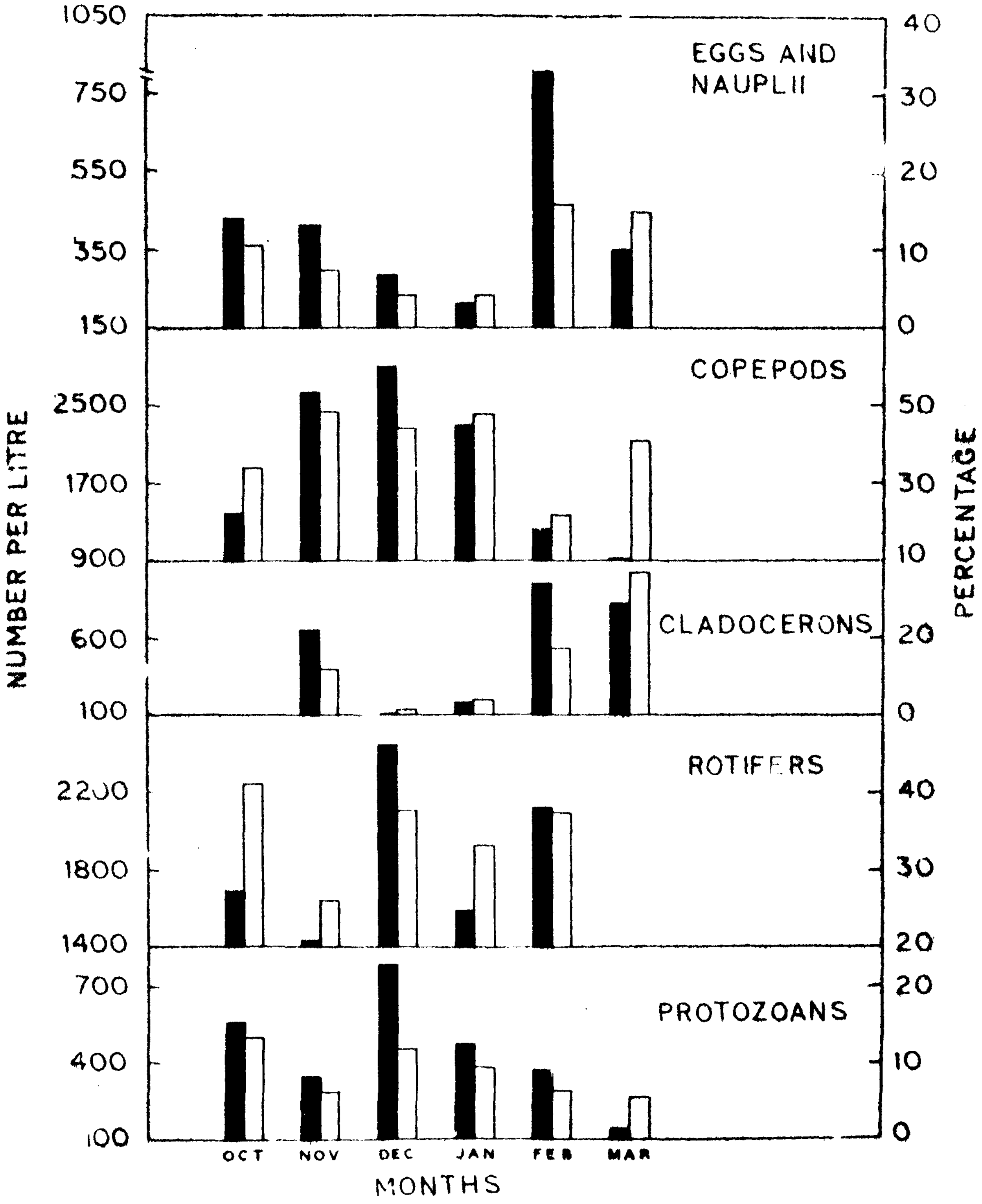

PHYTOFLAGELLATES
DIATOMS
DESMIDS
GREEN ALGAE
BLUE-GREEN ALGAE
NUMBER PER LITRE
PERCENTAGE
400000
300000
200000
100000
0
80000
60000
40000
30000
20000
10000
80000
60000
20000
80000
60000
40000
20000
40
30
20
10
0
40
20
0
20
10
0
40
20
0
40
30
20
10
OCT
NOV
DEC
JAN
FEB
MAR
MONTHS

Fig. IV

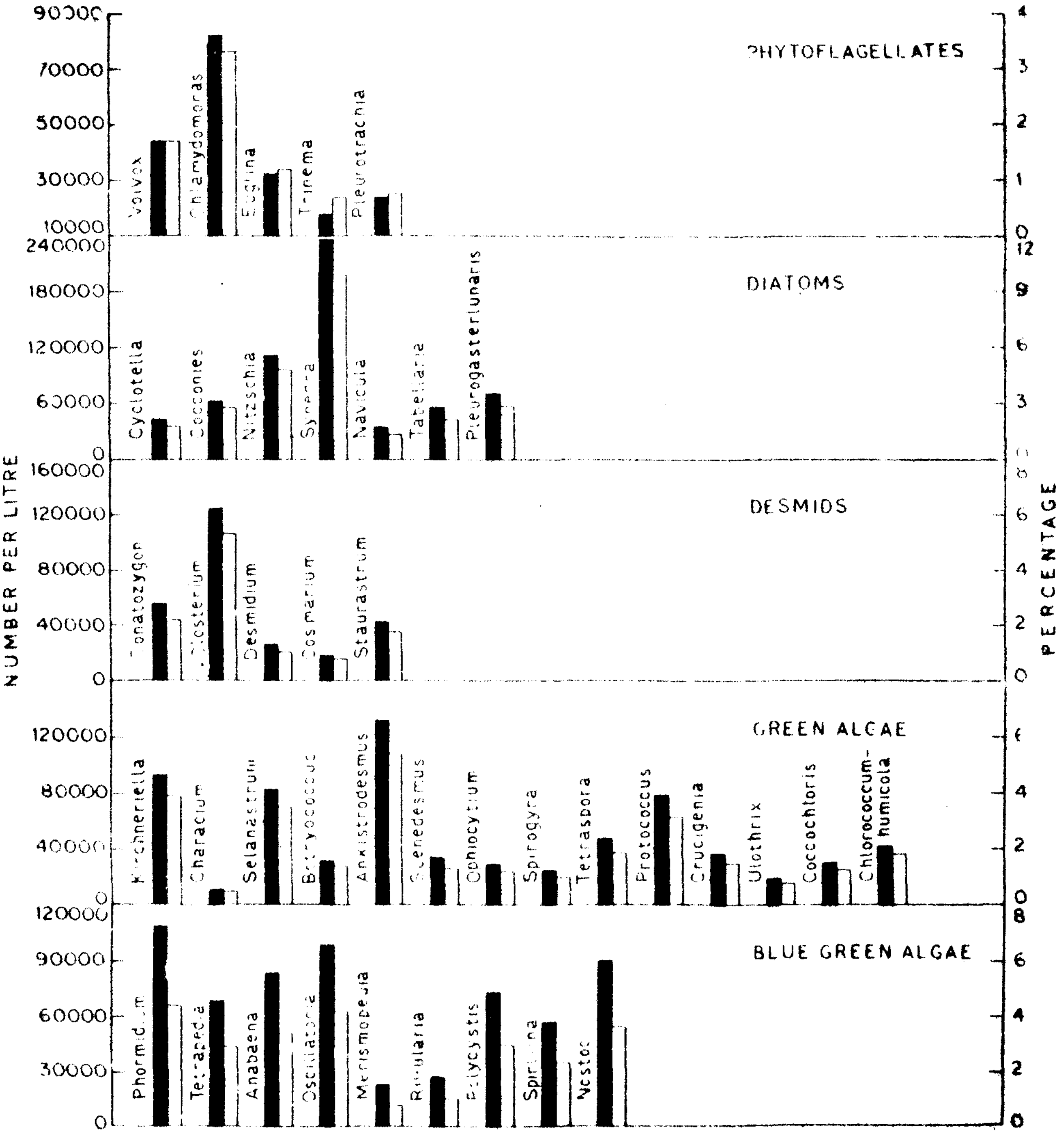
Mean total number (black bars) and percentage (white bars) of different genera of phytoplankton of six month's sampling.



EGGS AND NAUPLII
COPEPODS
CLADOCERONS
ROTIFERS
PROTOZOANS
NUMBER PER LITRE
PERCENTAGE
1050
750
550
350
150
2500
1700
900
600
100
2200
1800
1400
700
400
100
40
30
20
10
0
50
30
10
20
0
40
30
20
20
10
0
OCT
NOV
DEC
JAN
FEB
MAR
MONTHS

Fig.III

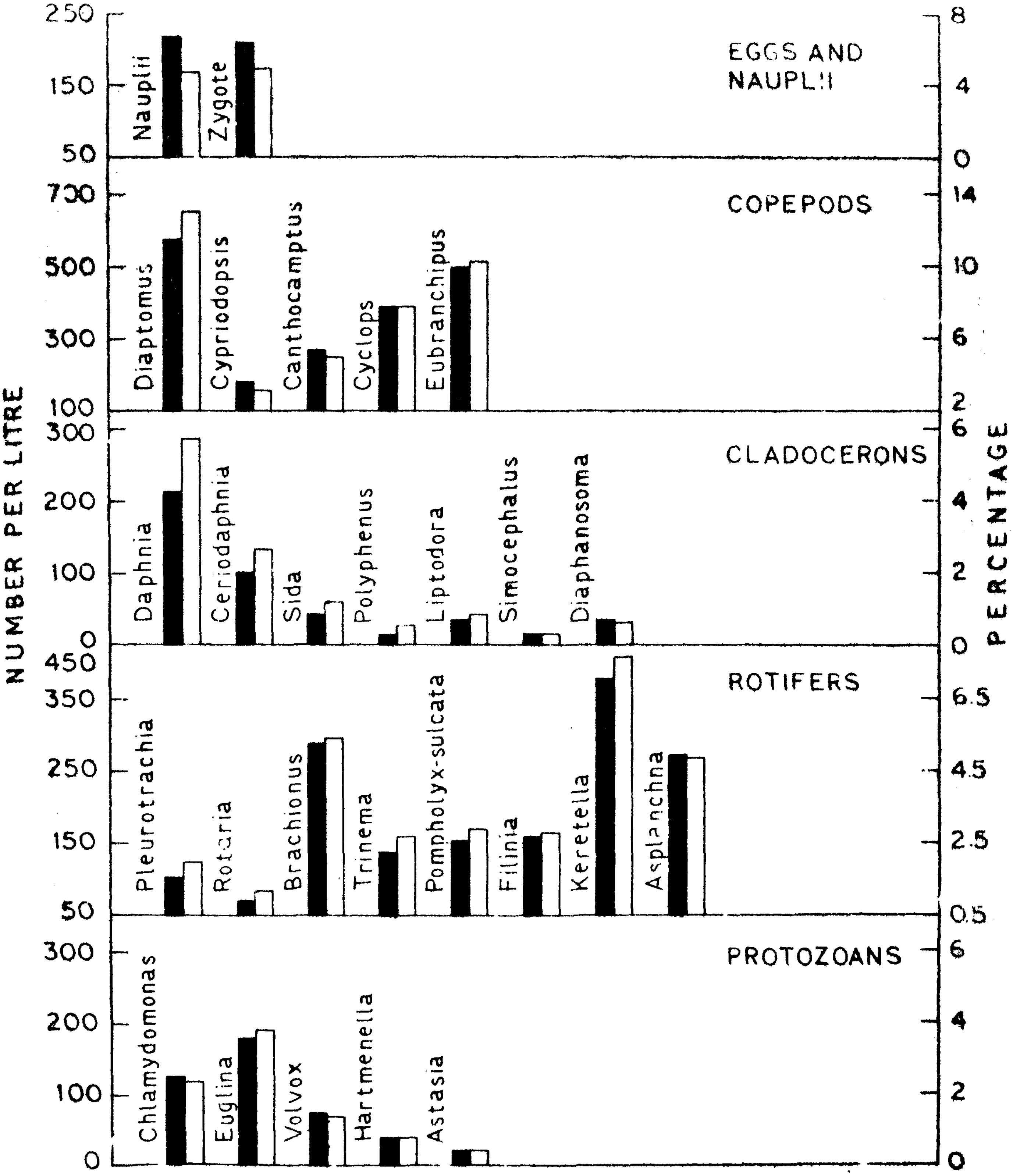
Abundance of main groups of zooplankton in the pond in different months (total number indicated by black bars & percentage by white bars).



NUMBER PER LITRE
PERCENTAGE
PHYTOFLAGELLATES
Volvox
Chlamydomonas
Euglina
Trinema
Pleurotrachnia
DIATOMS
Cyclotella
Cocconies
Nitzschia
Synedra
Navicula
Tabellaria
Pleurogasterlunaris
DESMIDS
Gonatozygon
Closterium
Desmidium
Cosmarium
Staurastrum
GREEN ALGAE
Kirchneriella
Characium
Selanastrum
Botryococcus
Ankistrodesmus
Scenedesmus
Ophiocytium
Spirogyra
Tetraspora
Protococcus
Crucigenia
Ulothrix
Coccochloris
Chlorococcum-humicola
BLUE GREEN ALGAE
Phormidium
Tetrapedia
Anabaena
Oscillatoria
Merismopedia
Rivularia
Polycystis
Spirulina
Nostoc

Fig. V

Mean total number (black baru) and percentage (white bars) of different genera of zooplankton of six month's sampling.


NUMBER PER LITRE
PERCENTAGE
EGGS AND NAUPLII
Nauplii
Zygote
COPEPODS
Diaptomus
Cypriodopsis
Canthocamptus
Cyclops
Eubranchipus
CLADOCERONS
Daphnia
Ceriodaphnia
Sida
Polyphenus
Liptodora
Simocephalus
Diaphanosoma
ROTIFERS
Pleurotrachia
Rotaria
Brachionus
Trinema
Pompholyx-sulcata
Filinia
Keretella
Asplanchna
PROTOZOANS
Chlamydomonas
Euglina
Volvox
Hartmenella
Astasia

PART - II

PRIMARY PRODUCTION

INTRODUCTION

The productivity of an aquatic environment basically depends on the photosynthetic activity of the chlorophyll bearing organisms involving transformation of carbondioxide to organic molecules and their assimilation in the body. In addition to the biosynthesis of organic matter, oxygen is also released as a by_product of this process. An important use of this oxygen lies in organismal respiration. During the last two decades, interest in the primary production of fresh-water ecosystems has greatly increased and various methods of productivity measurements advanced. The standard 'light and dark bottle 'method which was suggested as early as 1927 by Gaarder & Gram is still widely used because of its convenience and approximation of the values obtained by application of this technique to the ones derived by more sophisticated methods such as the C^{-14} technique.

This chapter embodies the data on the primary productio in a perennial and sewage - fed local pond at Aligarh wherein cultivation of major carps is carried out by private sector not inclined to manage the fish populations on scientifically recommended rational basis.

MATERIALS AND METHODS

Primary productivity of the pond was measured at two fixed sites by the help of standard 'light and dark bottle' method. One set of light and dark bottles containing 250 ml of environmental sample was suspended at one site and a similar set at the other, in the surface layer of water at a depth of about 1 ft. at 9 A.M. One pair of the bottles was taken out after 4 hours and the other one after 8 hours. Dissolved oxygen concentration of the containing water was determined by Wrinkler's technique. Difference in the dissolved oxygen values of the water contents of light and dark bottles gave an idea of the total oxygen release during photosynthetic activity of organisms, oxygen utilization by the confined organisms in their respiration and the net amount of oxygen in the light bottle. The total and net oxygen values were multiplied by a factor 0.375 (Sreenivasan, 1964b) to get the total (gross) and net primary productivity interms of organic carbon assimilation. The study was extended over a period of six months (October, 1980 - March, 1981).

RESULTS AND DISCUSSION

Data pertaining to oxygen generation during photosynthesis, organismal respiration and carbohydrate synthesis have been tabulated (Table-I).

During the course of study, the net production value was found to be maximum (3.225 mg c/m^3/8 h) in March and lowest in November and January (1.162 mg c/m^3/8 h). The high value in March could be due to more extensive littoral zone characterised by the abundance of macro vegetation Sounderraj *et al*. (1975) and Kannan & Job(1980b) correlated high production values in impoundments with growth of phytoplankton population. This is in contrast to the present investigations revealing coincidance of high production with low numerical decline in the phyto-plankton in the water. Perhaps temperature and transparency of water were the over riding factors. Lower temperature and poor sun shine evidently reduce the amount of organic carbon assimilation. The findings of Sounderraj *et al*. (1975) and Ahmed (1981) lend credence to this view.

SUMMARY

Primary production in a perennial freshwater pond was investigated over a period of six months(October - March). Monthly variations in the production values were recorded. The data have been interperated in the light of observed factors and published information.

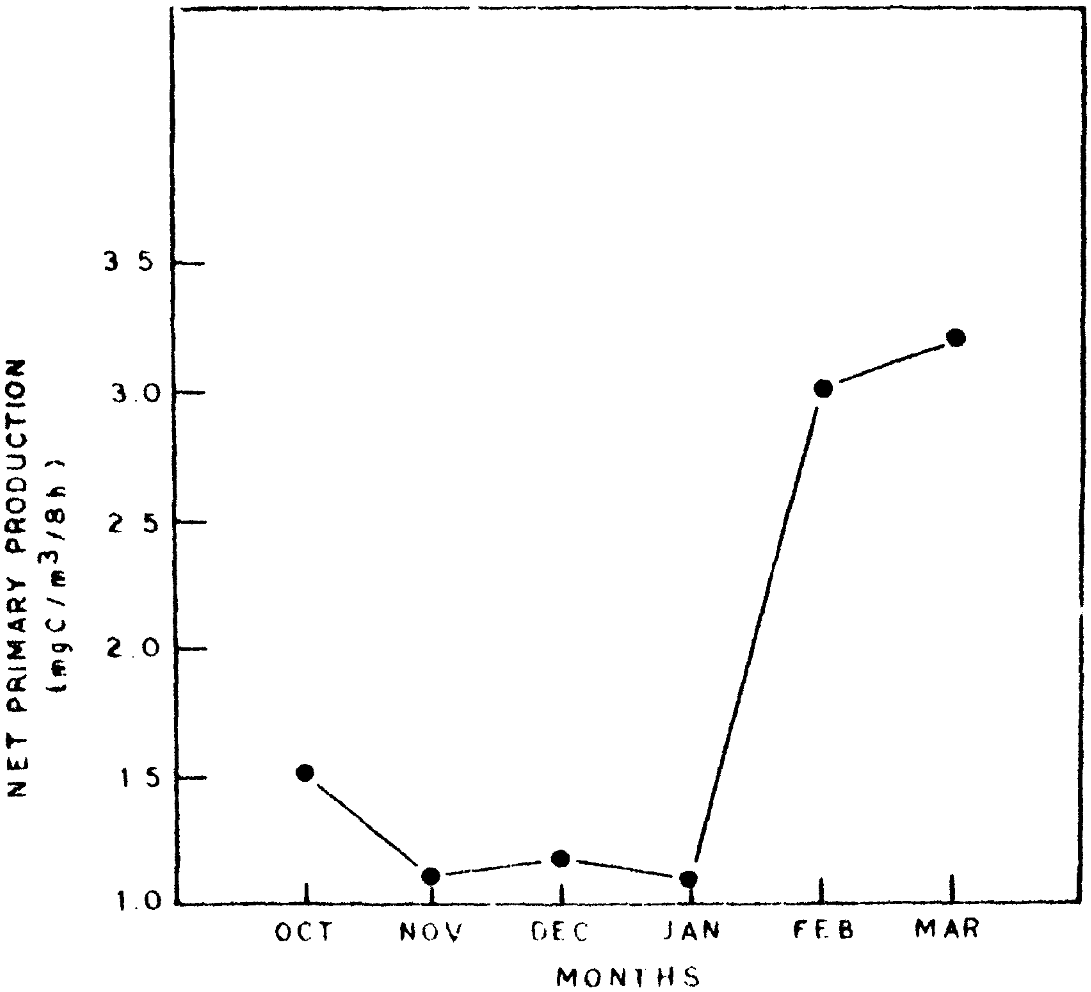
TABLE - 4

DISSOLVED OXYGEN AND ORGANIC PRODUCTION IN THE POND

Months	Initial dissolved oxygen at 9.00 A.M. (I) ppm	Final dissolved oxygen in Light bottle (L) ppm		Final dissolved oxygen in Dark bottle (D) ppm		Net Photosynthetic Oxygen production (L - I) ppm		Gross Photosynthetic oxygen production (L - D) ppm		Amount of Oxygen use in respiration. (I - D) ppm		Gross primary production (L - D) x 0.375 mg $C/m^3/8h$		Net primary production (L - I) x 0.375 mg $C/m^3/8h$		Total primary production mg $C/m^3/8h$
		1 PM	5 PM	1 PM	5 PM	1 PM	5 PM	1 PM	5 PM	1 PM	5 PM	1 PM	5 PM	1 PM	5 PM	
October	6.4	9.4	10.5	5.8	2.6	3.0	4.1	3.6	7.9	0.6	3.8	1.35	2.9625	1.225	1.5375	1.5375
November	4.9	7.1	8.0	3.9	2.0	2.2	3.1	3.3	6.0	1.1	2.9	1.2375	2.25	0.825	1.1625	1.1625
December	5.2	7.5	8.4	4.6	2.2	2.3	3.2	2.9	6.2	0.6	3.0	1.0875	2.325	0.8625	1.2	1.2
January	4.3	5.9	7.4	3.1	1.9	1.6	3.1	2.8	5.5	1.2	2.4	1.05	2.0625	0.60	1.1625	1.1625
February	2.7	9.5	10.8	1.6	0.6	6.8	8.1	7.9	10.2	1.1	2.1	2.9625	3.825	2.55	3.0375	3.0375
March	2.5	8.3	11.1	1.9	1.4	5.8	8.6	6.4	9.7	0.6	1.1	2.4	3.6375	2.175	3.225	3.225

Fig. I

Net primary production in the pond in different months.



NET PRIMARY PRODUCTION
(mg C / m3 / 8 h)
3.5
3.0
2.5
2.0
1.5
1.0
OCT
NOV
DEC
JAN
FEB
MAR
MONTHS

PART - III

BOTTOM FAUNA

INTRODUCTION

Benthic organisms of a pond play an important role in the trophic cycle. A Survey of literature, however, reveals that information on the biology and productivity of the bottom communities is meagre compared to the data on these aspects of the organisms of the water column, comprising of plankton and nekton. Important contributions to the biology of animals living at the base of lacustrine habitat are those of Eggleton (1931, 1935), Miyadi (1931), Moore (1939), Deevey (1941), Srivastawa (1955, 1956), Krishnamurthy (1966), Moitra & Bhowmick (1968), Micheal (1968) and Mandal & Moitra (1975). An attempt has been made to provide information on the macrofauna of a perennial and sewage water pond.

MATERIALS AND METHODS

Bottom samples of the pond water collected regularly from October 1980 - March 1981 on monthly basis. Collection (inreplicate) was carried out with the help of Ekman - dredge (15.5 x 15.5 cm) from two different locations in the pond Each sample was put to pass through a combination of seives of different numbers (25, 30, 52) with sufficient quantity of water. Organisms remaining in different seives were reported, identified and counted. The number of the various organisms was expressed per meter square using the formula outlined by Welch (1948):

$$n = \frac{0}{a \times s} \times 1000, \text{ where}$$

n = Number of organisms/m^2

o = Number of organsims counted

a = Area of Ekman-dredge

s = Number of replicates taken

RESULTS

The benthic invertebrates of the pond recorded during present investigation belonged the orders Oligochaeta, Gastropoda, Deptera, Hemiptera, Coleoptera and Odonata. The groupwise percentage composition and total numbers are given in Table-I Fig. I.

OLIGOCHAETA: This group which was constituted mainly of *Tubifix*, *Aelosoma* and *Nais* formed 12.8% of the total bottom fauna. *Tubifix* dominated other Oligochaeta. Lying next in abundance was *Aelosoma* followed by the *Nais*.

GASTROPODA: These molluscs outnumbered other groups of benthos. Their percentage was as high as 61%. The various genera noted in the course of the study were *Valvata*, *Lymnia*, *Sphaerium*, *Gyroulus*, *Amnicola*, *Campeloma* and *Viviparus*. Except *Viviparus* where population was highest in December and Lowest in January, all the others were moderately and evenly distributed, without marked variations in any month and from month to month.

DIPTERA: This was represented by chironomid and culicoid larvae. The former were absent altogether in the month of October but peaked in March, whereas the latter were present in all the months but climaxed in December. These two types of larvae accounted for about 15% of the bottom dwellers.

HEMIPTERA: This order of insects contributed about 4% of the benthos and comprised of *Nepa* and *Notonecta*, *Nepa* could not be noticed in February, while *Notonecta* was absent from the January sample.

COLEOPTERA: *Berosus* was the only genus of this group, occured in about the same percentage as that of Hemiptera. The population was maximum in December, but the animals vanished in January only to reappear in February.

ODONATA: This order was represented by the nymph stages contributing about 2% of the total inhabitants of the pond bottom. The animal occured abundantly in March, but the lowest population was encountered in October.

DISCUSSION

Investigations on the benthic organisms of ponds, lakes, reservoirs etc. reveals qualitative and quantitative variations in their population on seasional basis. The fluctuations have been attributed to a number of factors such as the preponderance of submerged vegetation and nature of the substratum. The present findings are in agreement with those of Aggus (1970) Baily *et al*. (1978) reported high population dencities of benthos in the months characterised by luxurient growth of the vegetation. It is quite likely that the submerged objects chiefly the macrovegetation facilitate the attachment of most invertebrates either in their adult or larval stages. The amount of sun light which governs the growth and survival of these plants evidently influences the population of the dependent macrafauna. The role of light has been discussed by Michael (1968). Kajak (1956) observed abundance of Oligochaets in regions rich in dicaying organic matter. Ahmad (1981) expressed the views that the availability of lime chiefly due to the decomposition of shells governs the growth of the gastropods population.

SUMMARY

Benthic fauna of a local pond was qualitatively and quantitatively analysed and monthly variations in the various communities observed. The factors affecting these fluctuation have been discussed.

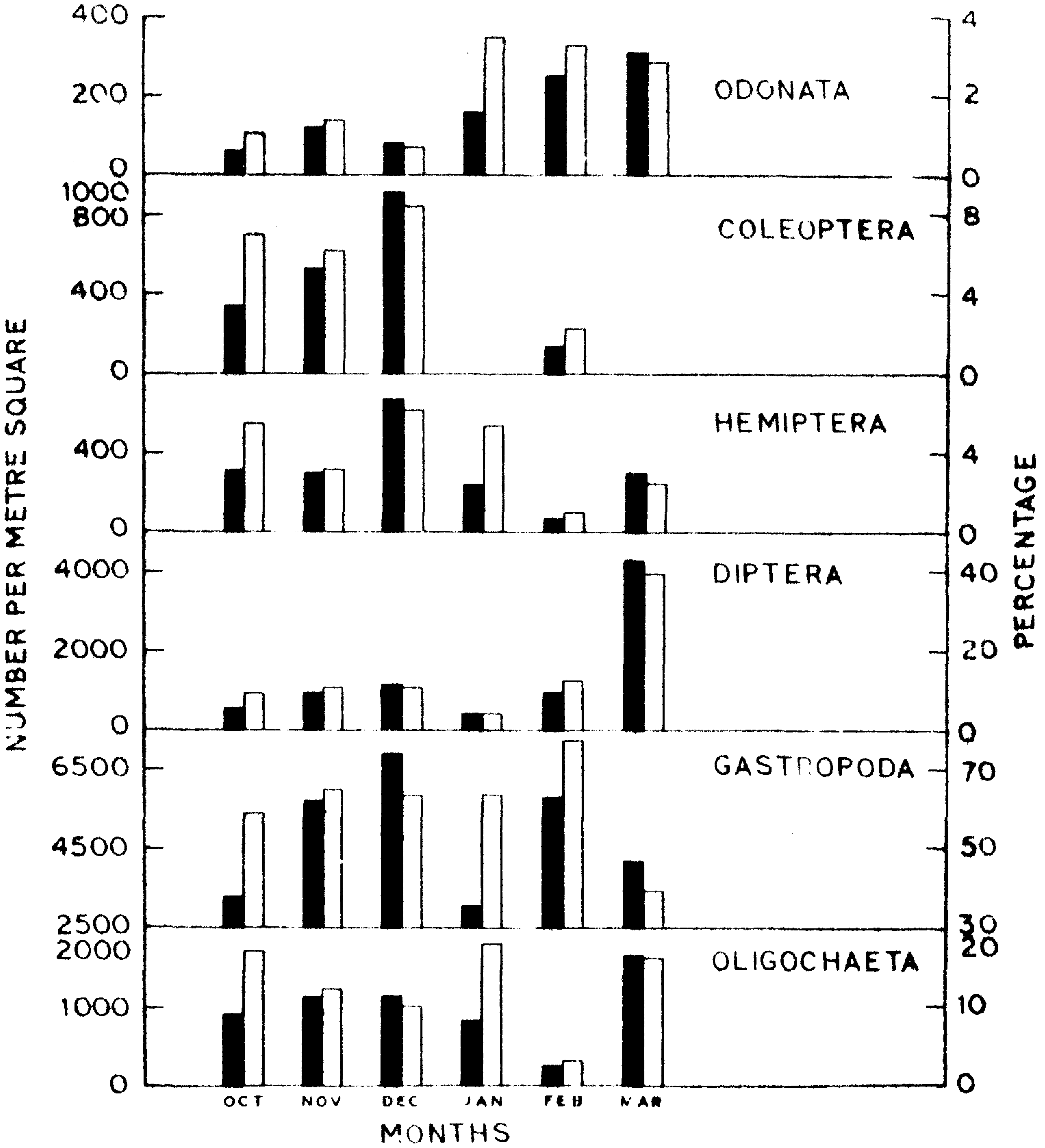
TABLE -I

BOTTOM FAUNA OF THE POND

Organism	October Total Number	October %	November Total Number	November %	December Total Number	December %	January Total Number	January %	February Total Number	February %	March Total Number	March %	Mean Total Number	Mean Percentage
Tubifix	728	13.1	843	9.7	655	6.0	479	10.0	177	2.4	707	6.6	598.16	7.96
Aelosoma	198	3.6	270	3.1	385	3.5	395	8.2	-	-	936	8.7	364	4.52
Nais	21	0.4	-	-	83	0.7	-	-	62	0.8	-	-	27.66	0.32
OLIGOCHAETA	947	17.1	1113	12.8	1123	10.2	874	18.2	239	3.2	1643	15.3	987.83	12.8
Valvata	-	-	-	-	-	-	-	-	-	-	52	0.5	8.66	0.08
Lymnia	125	2.2	177	2.0	73	0.7	114	2.4	83	1.1	21	0.2	98.83	1.43
Sphaerium	-	-	-	-	-	-	-	-	-	-	42	0.4	7.0	0.07
Gyraulus	250	4.5	343	3.9	94	0.8	62	1.3	135	1.8	187	1.7	178.5	2.33
Amnicola	-	-	-	-	177	1.6	250	5.2	416	5.6	187	1.1	171.66	2.35
Campilema	42	0.7	125	1.4	-	-	-	-	62	0.8	-	-	38.17	0.48
Viviparus	2872	51.7	5036	57.8	6566	60.0	2612	54.5	5078	68.0	3713	34.6	4312.83	54.43
GASTROPODA	3289	59-1	5681	65.1	6910	63.1	3038	63.4	5774	77.3	4202	39.1	4815.66	61.18
Chironomous-*larvae*	-	-	125	1.4	281	2.6	135	2.8	707	9.5	3819	35.6	844.5	8.65
Culicoids	531	9.5	801	9.2	895	8.2	302	6.3	229	3.1	427	4.0	530.83	6.72
DIPTERA	531	9.5	926	10.6	1176	10.8	437	9.1	986	12.6	4246	39.6	1375.33	15.36
Nepa	208	3.7	73	0.8	177	1.6	281	5.8	-	-	270	2.5	168.17	2.4
Notonecta	125	2.3	229	2.6	512	4.7	-	-	83	1.1	42	0.4	165.17	1.83
HEMIPTERA	333	5.9	302	3.4	689	6.3	281	5.8	83	1.1	312	2.9	333.33	4.23
Berosus (COLEOPTERA)	395	7.1	562	6.4	957	8.7	-	-	187	2.5	-	-	350.17	4.12
Nymph (ODONATA)	62	1.1	125	1.4	83	0.7	166	3.5	250	3.3	312	2.9	166.33	2.15
TOTAL BENTHIC FAUNA	5557		8709		10938		4796		7400		10715			

Fig. I

Abundance of main groups of bottom organisms in the pond in different months (total number indicated by black bars & percentage by white bars).



ODONATA
COLEOPTERA
HEMIPTERA
DIPTERA
GASTROPODA
OLIGOCHAETA
NUMBER PER METRE SQUARE
PERCENTAGE
MONTHS
OCT
NOV
DEC
JAN
FEB
MAR

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